SURGICAL ADHESIVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to surgical adhesive.

2. Description of the Prior Art

It is known that urethane prepolymer from polyester is used as surgical adhesive (Progr. neurol. Surg., Vol. 3, pp. 116–168, Karger, Baseland Yearn Book, Chicago 1969).

Such prepolymer, however, has drawbacks that, due to its very slow and ununiform curing characteristics, poor adhesive strength has been often found, as applied in vascular graft, resulting in massive bleeding.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a rapidly curable surgical adhesive.

It is another object of this invention to provide an surgical adhesive having high improved bonding power for tissues.

It is still another object of the invention to provide surgical bonding means with improved elasticity or flexibility.

It is yet another object of the invention to provide adhesive for surgery of lower toxicity.

Briefly, these and other objects of the present invention as hereinafter will become more readily apparent have been attained broadly by a surgical adhesive, which comprises [A] NCO-terminated hydrophilic urethane prepolymer derived from hydrophilic polyether polyol of higher oxyethylene content, or combination of [A] with [B] unsaturated cyano compound containing cyano group attached to a carbon atom constituting the polymerizable double bond.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Said NCO-terminated hydrophilic urethane prepolymer [A], used in the surgical adhesive according to the invention, can be derived from at least one organic polyisocyanate (a) and at least one hydrophilic polyether polyol (b) with or without one or more other polyols (c).

Illustrative of suitable hydrophilic polyether polyols (b) are adducts of ethylene oxide [hereinafter referred to as EO] or combinations thereof with other alkylene oxide(s) [hereinafter refferred to as AO] to one or more compounds containing at least two active hydrogen atoms, such as polyhydric alcohols, polyhydric phenols, amines, polycarboxylic acids, phosphorous acids and the like. Suitable examples of polyhydric alcohols include dihydric alcohols, such as ethylene glycol, propylene glycol, 1,3- and 1,4-butane diols, 1,6-hexane diol, neopentyl glycol, diethylene glycol, bis(hydroxymethyl)cyclohexane, bis(hydroxyethyl)benzene, hydrogenated bisphenol A, hydrogenated bisphenol F, polytetramethylene glycols, polyester diols and silanol-terminated polysiloxanes; trihydric alcohols, such as glycerol, trimethylol propane, trimethylol ethane, 1,2,3-butane triol, 1,2,6-hexane triol and polyester triols; and polyhydric alcohols having 4–8 or more hydroxyl groups, such as pentaerythritol, diglycerol, alpha-methylglucoside, sorbitol, xylitol, mannitol, glucose, fructose, sucrose, and the like. Exemplary of suitable polyhydric phenols are mono- and poly-nuclear phenols, such as hydroquinone, catechol, resorcin, pyrogallol, and bisphenols [bisphenol A, bisphenol F, bisphenol S and the like], as well as phenol-formaldehyde condensation products. Suitable amines are inclusive of ammonia; alkanol amines, such as mono-, di- and tri-ethanol amines, isopropanol amines and the like; aliphatic, aromatic, araliphatic and alicyclic monoamines, such as C_1–C_{20} alkyl amines [methyl, ethyl, isopropyl, butyl, octyl and lauryl amines, and the like], aniline, toluidine, naphthyl amines, benzyl amine, cyclohexyl amine and the like, aliphatic, aromatic, araliphatic and alicyclic polyamines, such as C_2–C_6 alkylene diamines [ethylene diamines], diethylene triamine, tolylenediamines, phenylenediamines, xylylenediamines, methylenedianilines, diphenyletherdiamines, isophoronediamine, cyclohexylenediamines, dicyclohexylmethanediamines and the like; and heterocyclic polyamines, such as piperazine, N-aminoethyl-piperazine, and other heterocyclic polyamines, written in Japan Patent Publication No. 21044/1980.

Suitable AO, which may be employed in combination with EO for producing polyether polyols, include, for example, propylene oxide [hereinafter referred to as PO], 1,2- 2,3- ,1,3- and 1,4-butylene oxides, styrene oxide, epichlorohydrin and the like, as well as combinations of two or more of them. Among these, preferred are PO.

Addition of EO or combination thereof with AO to active hydrogen atom-containing compounds can be carried out in the usual way, with or without catalysts [such as alkaline catalysts, amine catalysts and acidic catalysts], under normal or an elevated pressure, in a single step or multi-stages. Addition of EO and AO may be performed by random-addition, block-addition or combination of them [for instance random-addition followed by block-addition]. Preferred is random-addition.

Hydrophilic polyether polyols have equivalent weight (molecular weight per hydroxyl group) of usually 100–5,000, preferably 200–3,000, and oxyethylene content of usually at least 30%, preferably 50–90% by weight. Polyether polyols having equivalent weight higher than 5,000 are too viscous to be used as surgical adhesives; while equivalent weight less than 100 results in lack of flexibility required for surgical adhesives. Polyether polyols of oxyethylene content less than 30% by weight, having insufficient hydrophilic nature, have poor reactivity with body fluids resulting in reduced cure rate and poor bonding power with water-rich tissue. Content of the primary hydroxyl groups of polyether polyols is preferably at least 30%, more preferably at least 50%, most preferably at least 70%.

Other polyols (c), optionally used in conjunction with hydrophilic polyether polyols, include low molecular weight polyols and/or hydrophobic polyols. Examples of such polyols are polyhydric alcohols mentioned above [as raw materials for hydrophilic polyether polyols]; AO adducts (such as PO adducts) of these polyhydric alcohols or other active hydrogen atom-containing compounds; and polyester polyols. Illustrative examples of polyester polyols are condensation products of dihydric and/or trihydric alcohols [ethylene glycol, propylene glycol, 1,3- and 1,4-butane diols, 1,6-hexane diol, neopentyl glycol, diethylene glycol, glycerol, trimethylolpropane and the like] and/or polyether polyols [such as those described above] with dicarboxylic acids [aliphatic or aromatic dicarboxylic acids, such as glutaric, adipic, sebacic, fumaric, maleic, phthalic and ter-